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Forest Pest Management Report

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BIOLOGICAL EVALUATION
Western Spruce Budworm

Lincoln National Forest
and Mescalero Apache Indian Reservation
New Mexico

November 1983

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USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

PREPARED BY:

William Telfer
WILLIAM G. TELFER, Entomologist
Forest Pest Management

APPROVED BY:

Douglas L. Parker
DOUGLAS L. PARKER
Director of Forest Pest Management

ABSTRACT

The western spruce budworm, Choristoneura occidentalis Freeman, defoliated 108,800 acres of mixed conifer on the Lincoln National Forest and Mescalero Apache Indian Reservation in 1983, up from 6,625 acres in 1982. A survey conducted in August 1983 estimated egg mass densities Forest-wide at 53.3/m^2 of foliage. Defoliation is predicted to be heavy in 1984 and the acreage defoliated is expected to increase.

Pest management alternatives and recommendations are discussed in this report.

INTRODUCTION

The western spruce budworm, Choristoneura occidentalis Freeman, continued to cause defoliation of mixed conifer stands on the Lincoln National Forest (NF) and Mescalero Apache Indian Reservation (IR) in 1983. Visible defoliation, as based upon aerial detection surveys, increased substantially in 1982 and again in 1983.

An egg mass survey was conducted in August 1983 to determine the infestation trend and predict 1984 defoliation levels. Samples were taken from all analysis units with accessible defoliated stands. The analysis units were established during the Lincoln National Forest Western Spruce Budworm Environmental Analysis (see figures 1 and 2).

TECHNICAL INFORMATION

Insect. Western spruce budworm, Choristoneura occidentalis Freeman

Hosts. Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History. The western spruce budworm completes one generation each year (Furniss and Carolin 1977).

Stage	Time	Location on host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Large larvae	June	On buds and strobile
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation

1. Young larvae feeding on newly expanding buds and strobile.
2. Mature larvae consuming current year's needles.
3. Shoots webbed together by larvae.
4. Webbed shoots turning brown and falling from trees.
5. Defoliation most evident in upper crowns of trees.
6. Trees dying from the top downward after several years of heavy defoliation.

Extent of Outbreak. Defoliation was aerially detected on the Smokey Bear, Cloudcroft, and Mayhill Ranger Districts and the Mescalero Apache IR (figures 3-11). Defoliation estimates are as follows:

	Defoliation			
	Light	Moderate	Heavy	Total
Lincoln NF	32,150	12,900	0	45,050
Mescalero Apache IR	17,725	38,250	950	56,925
Nonindustrial Private	3,775	3,050	0	6,825
				108,800

Acres of defoliation has increased from 625 acres in 1981 to 6,625 acres in 1982 (Linnane 1982) and to 108,800 acres in 1983.

Threatened Resources. There are approximately 187,000 acres of mixed conifer type on the Lincoln NF and 65,000 acres of mixed conifer type on the Mescalero Apache IR. The infested stands generally have 1 to 2 years defoliation. Permanent tree damages have not yet occurred, but can be expected to occur within the next 2 years if the budworm population maintains the same level.

The severity of tree damage caused by the western spruce budworm is directly related to the intensity and duration of defoliation. Stands displaying good vigor and growth can withstand two to three consecutive years of intense budworm feeding without significant injury. However, stands displaying poor vigor and growth will suffer varied amounts of tree injury early in the outbreak cycle.

Generally, budworm infestations cause varied amounts of tree deformity, seedling damage, seed destruction, and stand regeneration failure. Stands subjected to four or more consecutive years of severe defoliation incur top-kill and mortality, principally in the smaller

size classes. Radial growth of defoliated trees is greatly reduced through the outbreak duration. Tree damages may be quantified as follows:

Tree damages	Maximum damages (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Top-killing	25
Cone crop reduction	90+
Christmas tree quality loss	90+

METHODS

An egg mass survey was conducted in August 1983 on the Lincoln NF and Mescalero Apache IR. Samples were taken from 55 plots on 7 analysis areas (figures 3-11).

Sample plots consisted of three dominant or codominant, relatively open-grown Douglas-firs, 30 to 50 feet tall. Two 70-cm foliated branches were pruned from opposite sides of the midcrown of each sample tree, for a total of six branches per plot. Branch samples were individually bagged in cloth sacks, labeled, and transported to a laboratory for examination. Samples were stored in a walk-in cooler at about 40° F.

Foliage was examined under ultraviolet light for egg masses. Needles with egg masses were classed as from current year's foliage or a previous year's foliage and kept separate in labeled pill boxes. New and old egg masses were separated by an experienced laboratory technician. All egg masses on the current year's foliage were classed as new and their characteristics formed the basis for aging egg masses found on previous years' foliage.

Defoliation projections for 1984 were determined from the density of 1983 egg masses using the following information presented by McKnight et al. (1970):

Egg mass density[a]	Predicted defoliation class[b]
1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations
9.30 to 31	Light for "static" infestations Moderate for "increasing" infestations
34.10	Moderate for "static" infestations Heavy for "increasing" infestations

[a]Number of egg masses per square meter of foliage.
[b]Defoliation class limits (percent of new growth).
Undetectable = <5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = >65 percent

RESULTS AND DISCUSSION

The extent and severity of the infestation increased dramatically in 1983. Sampling results are discussed by analysis units below and are summarized in table 1.

Carrizo Analysis Area

Small pockets of defoliation have been detected on or near Carrizo Peak in 1981, 1982, and 1983 (figure 3). The amount of host type on Carrizo Mountain is small, 1,256 acres, noncommercial, and nearly inaccessible. Egg mass samples were not taken.

Defoliation is expected to continue in 1984; however, no severe economic damages are expected to occur.

Capitan Analysis Unit

Several small pockets of light defoliation were reported in the Capitan Mountains in 1981 and 1983 (figure 4). No defoliation was found when the area was inspected in August 1983, so no egg mass sample plots were established. Most of the 31,995 acres of host type is in the Capitan Mountain Wilderness.

Again, small areas of defoliation are expected to continue without severe damages occurring.

White Mountain Analysis Unit

Defoliation was first detected by aerial surveys in 1983 (figure 5). Total acreage defoliated was 6,200 acres; there are 16,955 acres of host type in the analysis unit. Defoliation was detected on the ground in the Eagle Creek summer home area west to the ski basin road. Three plots were established in this area. The one plot in the Ruidoso analysis unit was added to the three White Mountain analysis unit plots for statistical reasons (table 1).

Although the standard error is high, the average number of egg masses per square meter of foliage, 82.2 ± 41.2, indicates that the acreage and severity of defoliation will increase in both units.

Sierra Blanca Analysis Unit

Aerial surveys first detected defoliation in 1982. Total acreage defoliated in 1983 was 11,975. Over half of this acreage was moderately defoliated. There are 21,355 acres of host type in the analysis unit. Defoliation was detected on the ground and sampled at the Rio Ruidoso Forks, Cienegita Canyon, and Carrizo Creek (figure 6). The egg mass density, 45.6 ± 9.9, indicates that severity and acreage of defoliation will increase in 1984, barring unforeseen natural mortality factors.

Ruidoso Analysis Unit

Western spruce budworm was first detected by aerial surveys in 1982. In 1983, the aerial survey detected defoliation on 3,625 acres, slightly more than the 2,252 acres of host type. The apparent anomaly between acres defoliated and acres of type results from stands consisting of up to 49 percent mixed conifer species being typed as ponderosa pine. One sample plot was established just south of where Eagle Creek forks (figure 7); it was included in the White Mountain analysis unit plots for statistical reasons. The infestation on the south side of Eagle Creek is expected to increase in severity and acreage in the same manner as the infestation near the Eagle Creek summer homes.

Mescalero Analysis Unit

Defoliation was first detected by aerial survey in 1982. Defoliation was detected on 44,950 acres in 1983. There are 44,019 acres of host type in the analysis unit. This exceeds the host type estimate for the same reason mentioned for the Ruidoso unit. Ground checking during egg mass sampling revealed that defoliation has been occurring for several years in many areas.

Sixteen sample plots were established in representative stands throughout the analysis unit (figure 8). The average number of egg masses per square meter of foliage, 37.6 ± 10.7, predicts heavy defoliation of 1984 foliage. Defoliation will also, most likely, become detectable on more acres in 1984. Tree damages will start to occur within the next 2 years, particularly to understory seedlings and saplings.

Cloudcroft Analysis Unit

Aerial detection surveys first detected western spruce budworm defoliation in the Cloudcroft analysis unit in 1982. Defoliation was detected on 1,975 acres in 1983. There are 1,453 acres of host type. Again, the discrepancy in acreage results from the reasons previously stated. Ground surveys revealed that many areas, particularly near the Silver and Little Apache Campgrounds, have had heavy defoliation for 2 or 3 years.

Ten sample plots were established throughout the analysis area. The average number of egg masses per square meter of foliage, 49.2 ± 7.2, predicts heavy defoliation of 1984 foliage. Permanent tree damages are expected to occur within the next 1 or 2 years, should the infestation continue.

Alamo Analysis Unit

Western spruce budworm defoliation was first detected on the analysis unit by aerial survey in 1982. Defoliation was detected on 21,000 acres in 1983. There are 57,261 acres of host type in the analysis unit. Ground surveys during the egg mass sampling revealed that defoliation is present at low levels in many areas that were apparently not visible during the aerial survey.

Ten sample plots were established throughout the analysis unit (figure 10). Average number of egg masses per square meter of foliage was 59.0 ± 12.3. This high level predicts heavy defoliation in 1984. The area of defoliation is expected to increase also. Permanent tree damages can be expected to start occurring after 2 to 3 years of infestation.

Sacramento Analysis Unit

Defoliation was first detected during an aerial survey in 1982. In 1983, defoliation increased to 16,025 acres. There are 66,939 acres of host type on the analysis unit.

Six sample plots were established throughout the analysis unit (figure 11). The average number of egg masses per square meter of foliage, 46.0 ± 8.7, indicates that heavy defoliation of 1984 foliage can be expected. The acreage of stands defoliated can be expected to increase also.

MANAGEMENT ALTERNATIVES

Management alternatives for the spruce budworm are discussed for the current infestation and then for future infestations.

Current Infestation

No Action. The budworm infestation is allowed to run its course, regulated only by natural factors. No silvicultural treatments are prescribed to lessen the impact of future infestations. This alternative should be used where, for any number of reasons, regular forest management activities cannot be utilized.

Effects of this alternative are:

1. This alternative would not be effective in preventing tree damages resulting from the current outbreak. Impacts of this damage to resource values and uses would have to be accepted under this alternative.

2. Costs associated with this alternative will be the value of the resources damaged. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation. Social impacts will result from the resource damage.

Suppression. Management actions are taken against the current infestation. These actions include: Suppression of the entire infestation by aerial application of insecticides; aerial application of insecticides on selected analysis units and/or stands; and protection of high-value trees with insecticides.

Insecticides registered by the U.S. Environmental Protection Agency for use against the budworm are:

1. Carbaryl (carbamate insecticide)

The Sevin 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West. An outbreak on the Santa Fe NF was successfully suppressed in 1977, and the outbreak has remained at a low level for 6 years (Telfer 1983). Carbaryl is a nonpersistent pesticide which is available for general use. One pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene Forest Spray (acephate) is a nonpersistent insecticide registered for use against the western spruce budworm and other forest defoliators. Although this insecticide has been shown to be effective against the budworm, it has never been used in the Southwest.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad-spectrum insecticide, registered for use against more than 100 insects, including the western spruce budworm. However, it is not recommended because it has yielded inconsistent results in suppressing outbreaks.

4. Mexacarbate (carbamate insecticide)

Mexacarbate (Zectran) is a nonpersistant pesticide which is available for use against the western spruce budworm. Mexacarbate is applied at a rate of 0.15 pounds of active ingredient per acre. No lasting environmental effects have been identified when properly applied at this rate.

5. Microbial Insecticides

Bacillus thuringiensis (*B.t.*), a bacterium, has been used experimentally and operationally in the Southwest. Results have shown that good western spruce budworm larval mortality can result; however, results can be highly variable. Thus, it is recommended that current formulations be used only in sensitive areas (for example, populated areas and stream courses) where chemical insecticides would not be acceptable.

Effects of this alternative are:

1. Aerial application of insecticides

a. Tree damages prior to treatment are accepted and may reduce the benefits of treatment, but further, more serious losses will be prevented. Serious defoliation may be prevented for up to 5 years after treatment.

b. Excessive losses to the timber and visual quality resources will be prevented.

c. Cost of this alternative are approximately $9 per acre.

d. Proper use of any of these insecticides will not pose a significant hazard to humans, wildlife, or the environment.

2. Treatment of high-value trees

a. Treated trees would be protected from defoliation.

b. Annual applications of an insecticide would be required during the outbreak, since the treated trees would be reinfested from nearby infested stands.

c. Application costs would be relatively low and cost effective.

d. Timber and visual quality resources will suffer losses.

e. Proper use of any of these insecticides will not pose a significant hazard to humans, wildlife, or the environment.

Future Infestations

Current Management. This is the same as No Action for the present infestation. No management actions are taken to reduce or prevent budworm-caused damages of possible future infestations.

Effects of this alternative are the same as for No Action on the current infestation, but for each future infestation.

Prevention. This alternative is the silvicultural manipulation of the mixed conifer type to create stand conditions that reduce the impact of future infestations. Silvicultural prescriptions for mixed conifer stands should emphasize "state-of-the-art" strategies for reducing stand budworm vulnerability/susceptibility. These strategies include: (a) Regeneration cuts designed to create more even-aged stands, with a lower percentage of true fir; (b) regeneration cuts with artifical regeneration of nonhost tree species; (c) intermediate cuts, such as thinning, improvement, and sanitation, to increase stand vigor, regulated stocking, and favor nonhost tree species; and (d) use of the above strategies to create a mosaic of different age class, even-aged stands.

Effects of this alternative are:

1. Impacts of future infestations may be reduced.

2. Overall, treated stands will be more vigorous and better able to withstand the impact of most pest organisms.

RECOMMENDATIONS

The Lincoln NF should consider all budworm management alternatives for each analysis unit using an integrated pest management decisionmaking process to arrive at the combination of budworm management alternatives that best reduces the impact of the budworm and protects the management objectives for that analysis unit.

Discussion of feasible budworm management alternatives for the analysis areas follows:

Carrizo and Capitan Analysis Units. Since the mixed conifer stands on these units are small, isolated, and are primarily in wilderness or are noncommercial areas, no action is recommended for the current outbreak.

Sierra Blanca, Ruidoso, Mescalero, Alamo, and Sacramento Analysis Units. Suppression is recommended for the current outbreak, subject to cost effectiveness. If aerial application of insecticides is chosen, the application should occur in 1984. By 1985, permanent tree damages will have occurred at a sufficiently high level to reduce or eliminate the benefits of the application. Also, budworm populations are expected to be at such high levels that effective control (post-spray population of less than 3 budworm larvae per 100 buds) may be difficult with a single application in 1984.

Prevention is recommended for future infestations on all commercial stands. This alternative can be implemented during the regular management activities in these stands that conform to the Forest plan.

White Mountain Analysis Unit. No action is the recommended alternative for the portions of the analysis unit that are within the wilderness area. Suppression, subject to cost effectiveness, for the current outbreak and prevention for future outbreaks are the recommended alternatives for the nonwilderness portions of the analysis unit.

Also, partial treatment of both the White Mountain and Ruidoso analysis areas to create buffer strips for the Sierra Blanca analysis unit may be a viable option within the management action alternative.

Cloudcroft Analysis Unit. Several options within the management action alternative for the current outbreak exist. The analysis unit can be aerially treated with insecticides, should the encompassing Alamo analysis unit be treated. Also, if no action is chosen for the Alamo analysis unit, treatment of high-value trees in the Cloudcroft analysis unit may be desirable.

Prevention for future outbreaks may not be viable, since most of the area is developed recreation sites or private lands.

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TABLE 1.--Summary of egg mass density and defoliation detected by aerial survey by analysis units, Lincoln National Forest, 1983

Analysis unit	New egg masses/square meter foliage ± SE and number of plots	Acres defoliated			
		L	M	H	Total
Carrizo	---	1,850	---	---	1,850
Capitan	---	1,200	---	---	1,200
White Mountain	82.2 ± 41.2 n=4	5,225	975	---	6,200
Sierra Blanca	45.6 ± 9.9 n=10	4,400	7,575	---	11,975
Ruidoso	One plot included in the White Mountain analysis unit	3,600	25	---	3,625
Mescalero	37.6 ± 10.7 n=16	13,325	30,675	950	44,950
Cloudcroft	49.2 ± 7.2 n=10	1,675	300	---	1,975
Alamo	59.0 ± 12.3 n=10	9,825	11,175	---	21,000
Sacramento	46.0 ± 8.7 n=6	12,550	3,475	---	16,025
Forest-wide average and total acres	53.3	53,650	54,200	950	108,800

FIGURE 1.--Location of the Carrizo, Capitan, White Mountain, Sierra Blanca, and Ruidoso analysis units

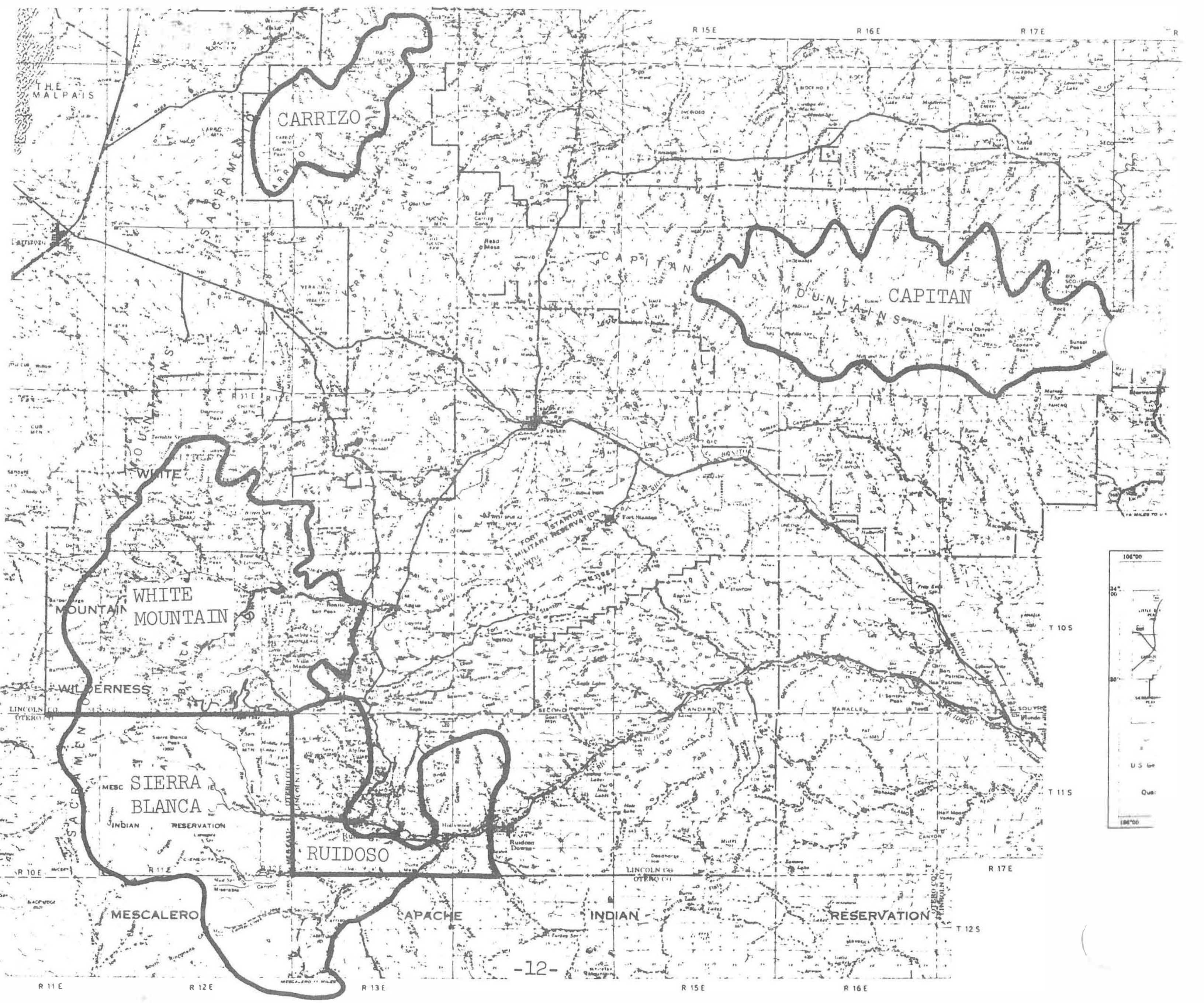


FIGURE 2.--Location of the Mescalero, Cloudcroft, Alamo, and Sacramento analysis units

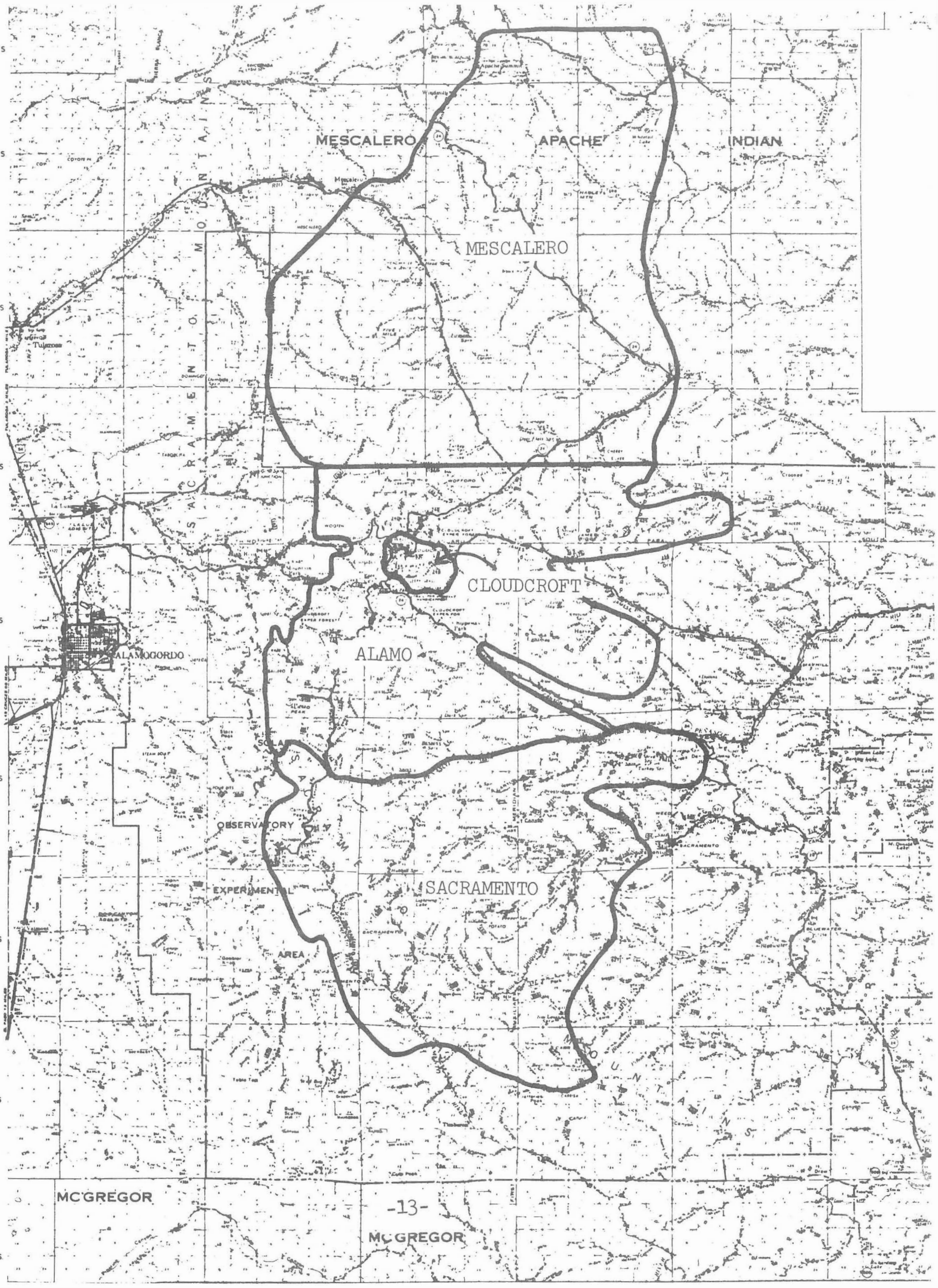


FIGURE 3.--Extent of western spruce budworm (WSBW) defoliation, Carrizo analysis unit, 1983

WSBW defoliation

L = Light
M = Moderate
H = Heavy

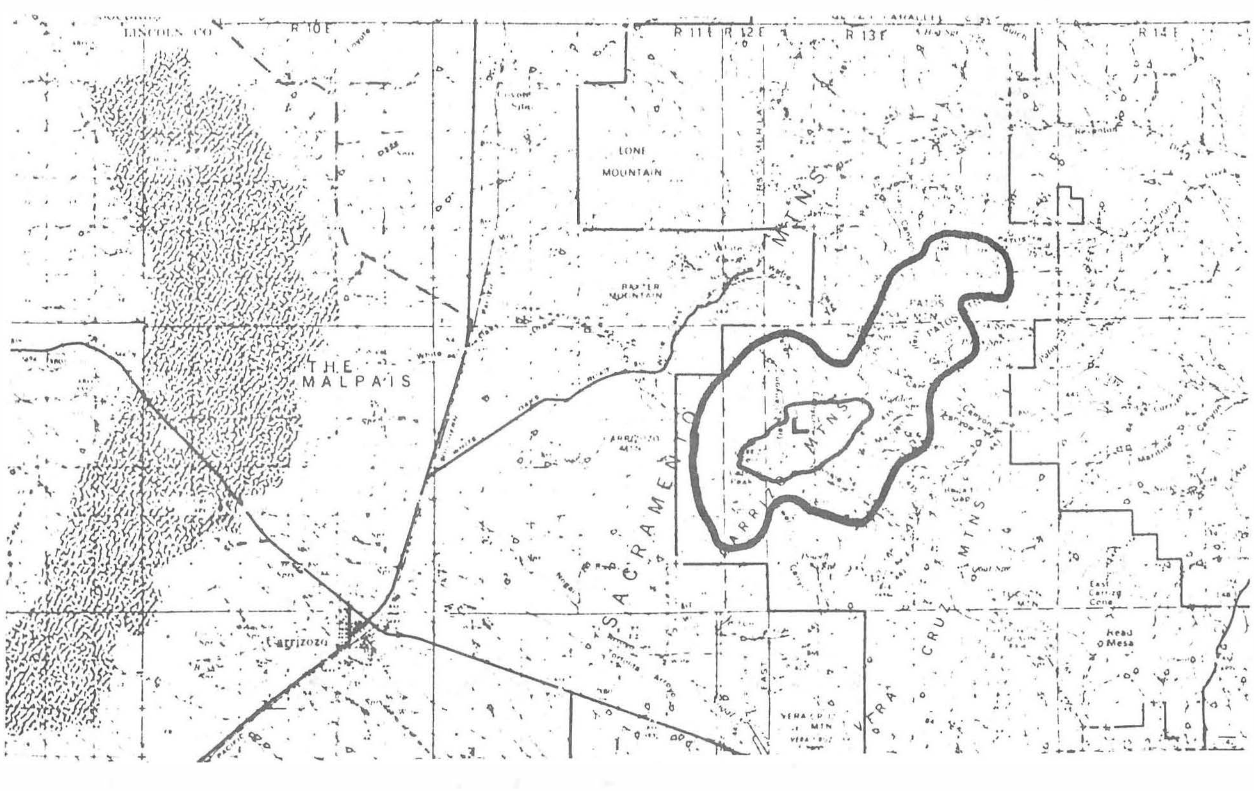


FIGURE 4.--Extent of western spruce budworm (WSBW) defoliation, Capitan analysis unit, 1983

L WSBW defoliation

L = Light
M = Moderate
H = Heavy

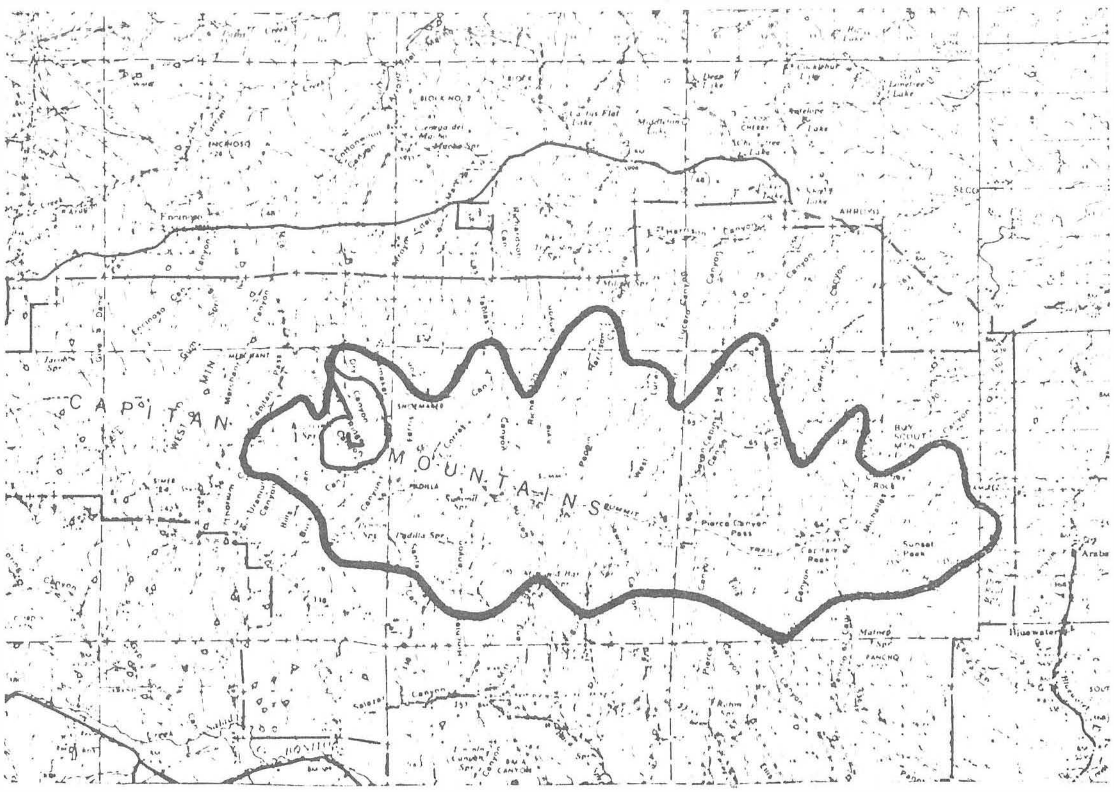


FIGURE 5.--Extent of western spruce budworm (WSBW) defoliation and sample plot location, White Mountain analysis unit, 1983

L WSBW defoliation

L = Light
M = Moderate
H = Heavy

● Sample plot location

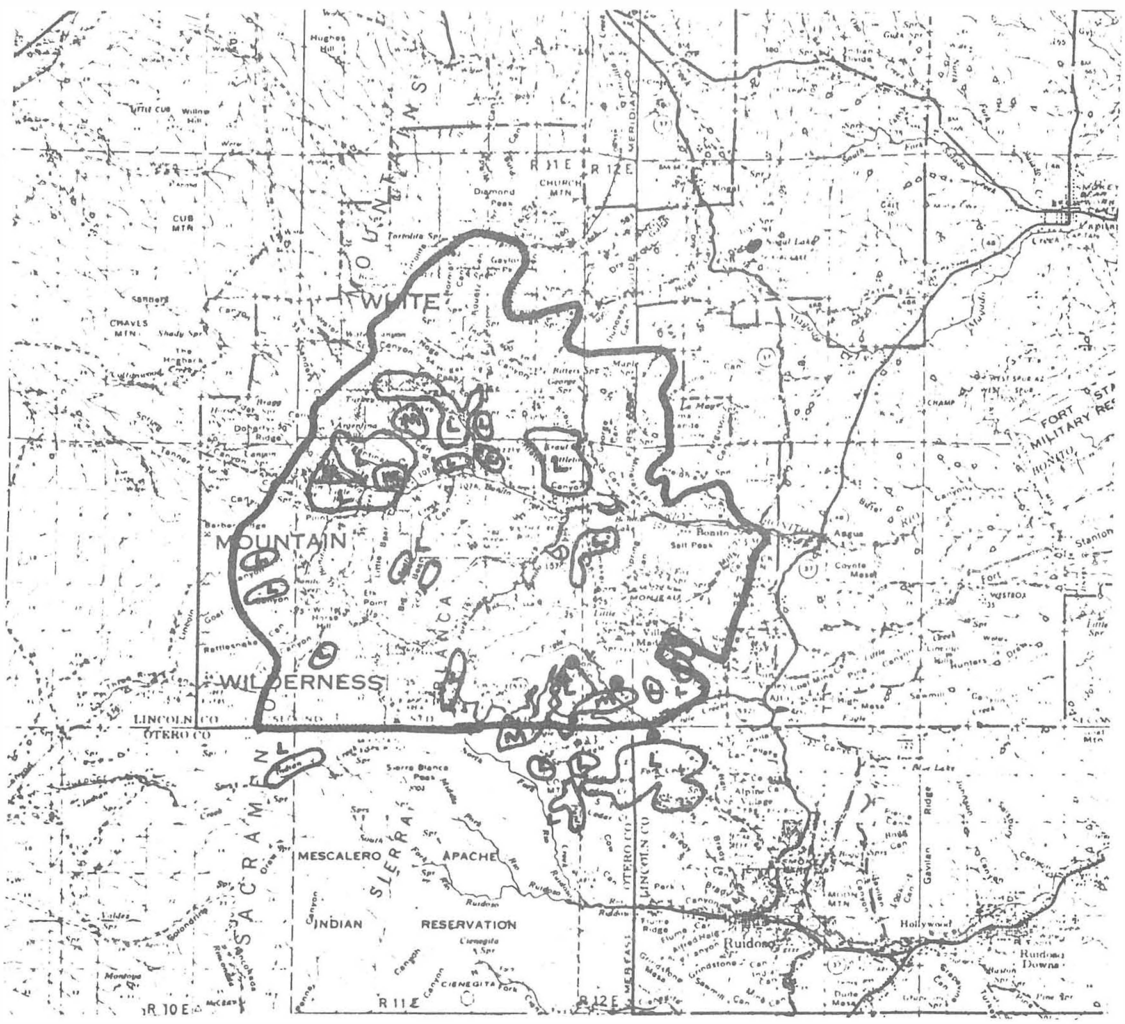


FIGURE 6.--Extent of western spruce budworm (WSBW) defoliation and sample plot location, Sierra Blanca analysis unit, 1983

WSBW defoliation

L = Light
M = Moderate
H = Heavy

● Sample plot location

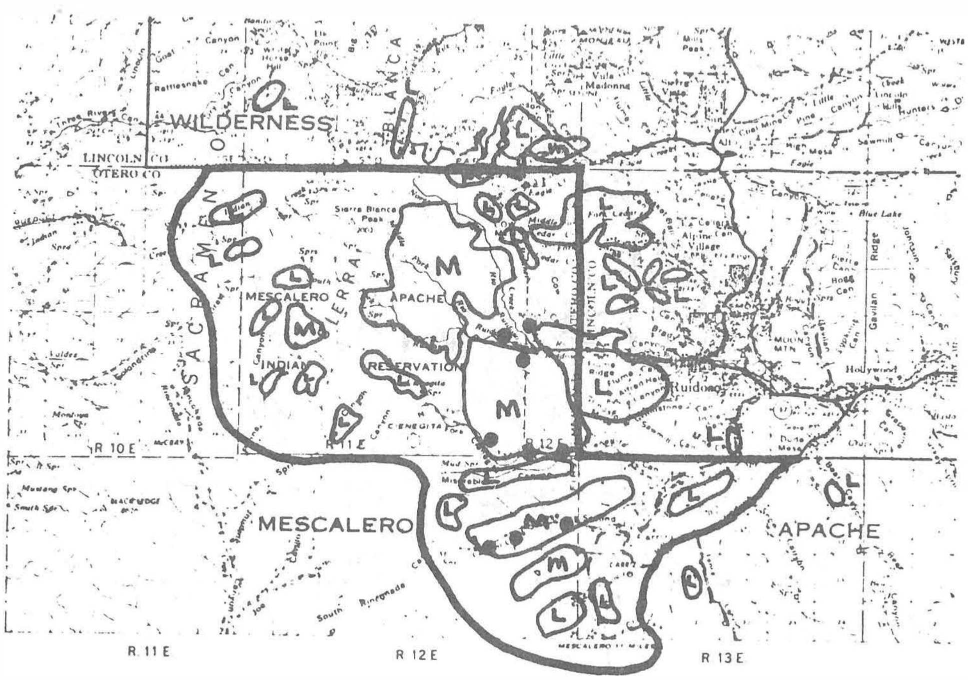


FIGURE 7.--Extent of western spruce budworm (WSBW) defoliation and sample plot location, Ruidoso analysis unit, 1983

L WSBW defoliation

L = Light
M = Moderate
H = Heavy

● Sample plot location

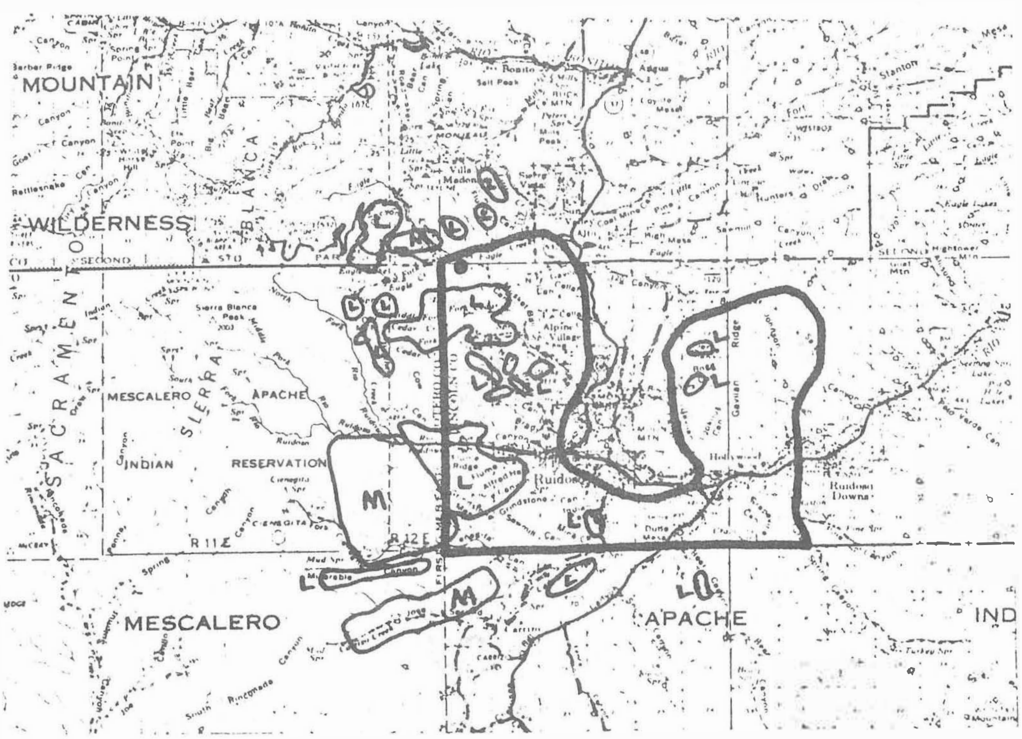


FIGURE 8.--Extent of western spruce budworm (WSBW) defoliation, Mescalero analysis unit, 1983

L WSBW defoliation

L = Light
M = Moderate
H = Heavy

● Sample plot location

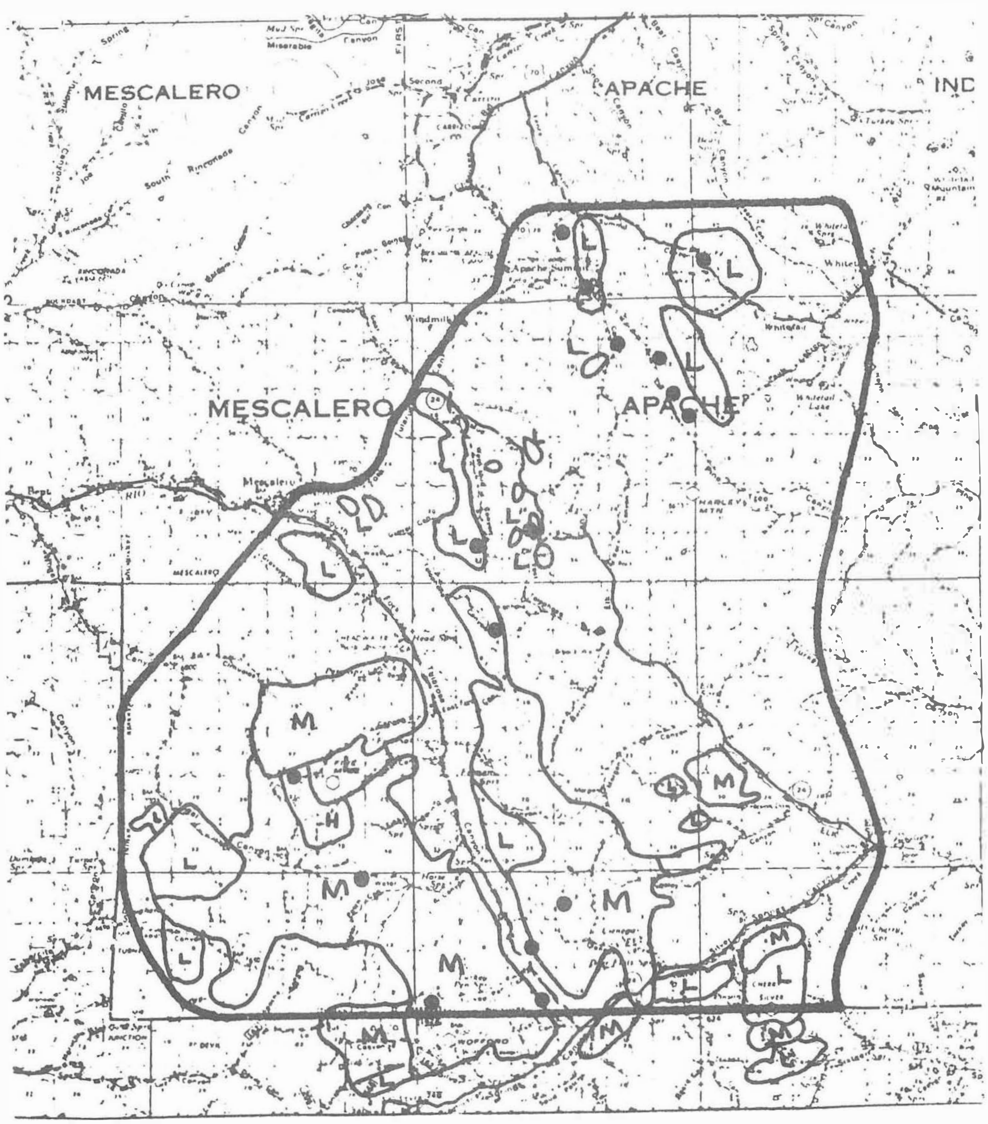


FIGURE 9.--Extent of western spruce budworm (WSBW) defoliation, Cloudcroft analysis unit, 1983

L WSBW defoliation

L = Light
M = Moderate
H = Heavy

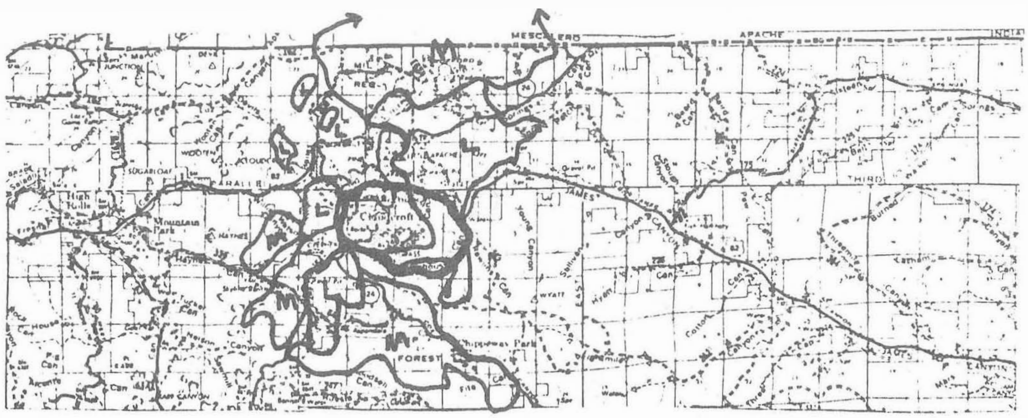


FIGURE 10.--Extent of western spruce budworm (WSBW) defoliation and sample plot location, Alamo analysis unit, 1983

WSBW defoliation

L = Light
M = Moderate
H = Heavy

● Sample plot location

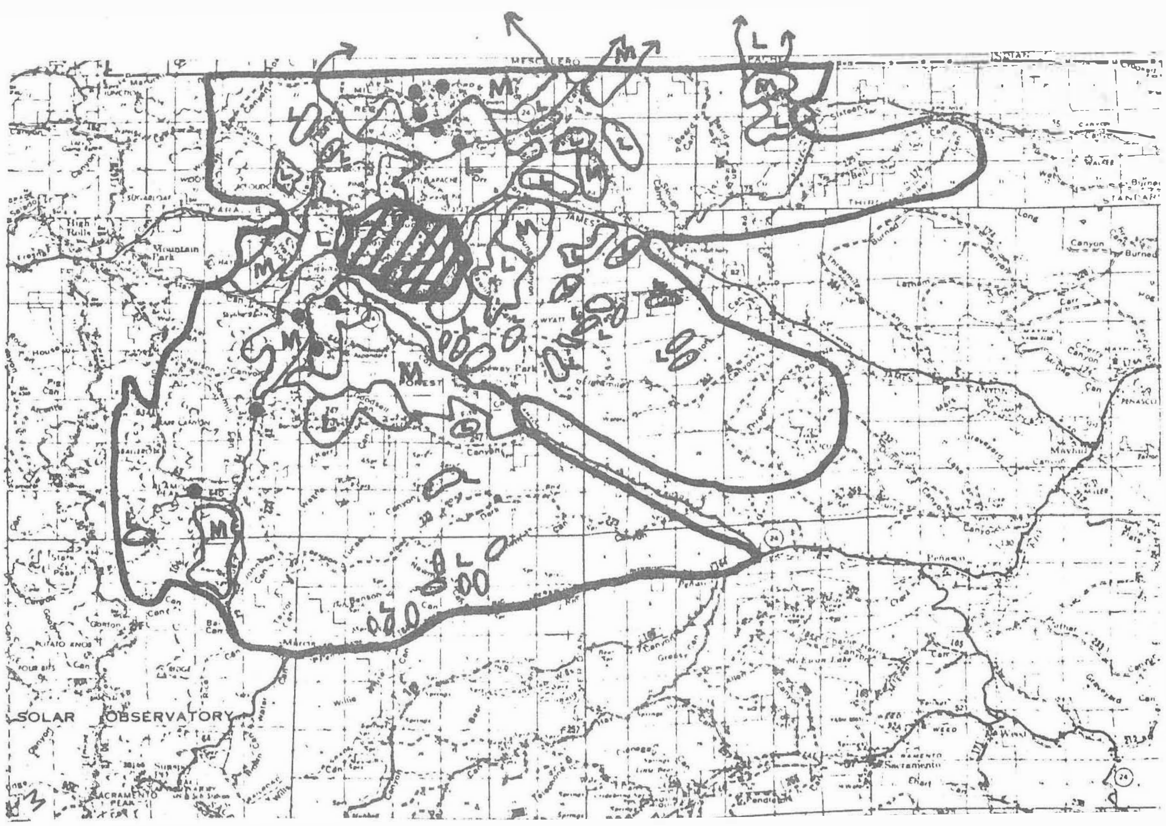
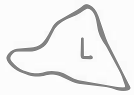


FIGURE 11.--Extent of western spruce budworm (WSBW) defoliation and sample plot location, Sacramento analysis unit, 1983



WSBW defoliation

L = Light
M = Moderate
H = Heavy

● Sample plot location